NASA's Mission Operations and Communications Services

This Description applies only to proposals in response to
NASA's Announcement of Opportunity for Earth System Science
Pathfinder Missions
AO-3

December 2000

TABLE OF CONTENTS

LIST OF TABLES

1.0 INTRODUCTION

This document is intended to assist in the preparation of proposals in response to an Announcement of Opportunity (AO) issued by NASA's Office of Earth Science for Earth System Science Pathfinder (ESSP) missions. To facilitate proposal preparation, services are described for the facilities operated by three organizations: the Telecommunications and Mission Operations Directorate (TMOD) at the Jet Propulsion Laboratory (JPL), the Goddard Space Flight Center (GSFC), and the Space Operations Management Office (SOMO), headquartered at the Johnson Space Center (JSC). NASA has consolidated management of space mission operations, space-ground communications, and ground wide area networks under the Space Operations Management Office at the Johnson Space Center. Consolidation of these systems, including the Deep Space Network (DSN), the NASA Ground Network (GN), the Tracking and Data Relay Satellite System (TDRSS), the NASA Information Services Network (NISN), and mission operations systems, was performed to enable migration to a common architecture across the agency, eliminate redundancy, and share resources. The ultimate objective is to reduce the cost of operations and increase funding available for science. Most space operations services are provided through a Consolidated Space Operations Contract (CSOC) with some selected services (e.g., international DSN sites) managed by NASA Centers. By providing this summary information, it is hoped that the task of preparing a proposal will be materially simplified.

1.1 COSTING POLICY

It is NASA’s policy to utilize mission operations strategies that yield the lowest life cycle cost to the Agency. NASA will include estimated costs of mission operations and communications services in the evaluation and selection processes for all earth science missions. The Office of Earth Science, working with the Office of Space Flight (Code M) and the Space Operations Management Office (SOMO), are implementing this policy:

- in anticipation of formal NASA-wide full-cost accounting,
- to better manage our currently oversubscribed communications resources,
- to encourage tradeoffs between on-board processing and storage vs. communications requirements, and
- to encourage proposers to design hardware and operations systems which minimize life cycle costs while accomplishing the highest-priority science objectives.

1.2 CHOICE OF SERVICE PROVIDERS

Proposers are free to use all, some, or none of the NASA-provided services for tracking, control, communications, and other services. Costs for such services, whether obtained from NASA or from other sources, ***must*** be included in the cost estimate. Early in

Phase B, the Office of Earth Science and the Space Operations Management Office (SOMO) will jointly consider other, broader NASA objectives that could result in NASA directing changes to the proposed approach. Selected investigations should be prepared to support tradeoff studies to be carried out by OES and SOMO during the investigation's definition study. Information on NASA SOMO mission operations and communications capabilities is provided in this document, with references to sources of more detailed information.

1.3 FURTHER INFORMATION

SOMO has delegated the responsibility for providing information and developing service commitments to representatives at select NASA centers. These representatives can provide information about NASA's mission operations and communications service plans and service price information. We recommend that initial inquiries be directed to the customer commitment representatives listed below.

GODDARD SPACE FLIGHT CENTER
Greenbelt, MD 20771

Mr. Jon Z. Walker , GSFC Customer Commitment Manager
Code 451
Phone: 301-286-7795 Fax: 301-286-0275
E-mail: jon.z.walker@gsfc.nasa.gov

JET PROPULSION LABORATORY
4800 Oak Grove Drive
Pasadena, California 91109-8099

Mr. Douglas G. Griffith, JPL Customer Commitment Manager
Code 920
Mail Stop 303-402
Phone: 818-393-3970 Fax: 818-393-1692
E-mail: douglas.griffith@jpl.nasa.gov

Mr. Charles Black, Deputy JPL Customer Commitment Manager
Code 920
Mail Stop 303-402
Phone: 818-354-0057 Fax: 818-393-6228
E-mail: Charles.A.Black@jpl.nasa.gov

For information about NASA's overall operations and communications service plans, contact:

John Dalton, SOMO Customer Commitment Manager
GSFC Code 720
Goddard Space Flight Center
Greenbelt, MD 20771

Phone: 301.286.5713 Fax: 301.286.1765
E-mail: john.dalton@gsfc.nasa.gov

1.4 STANDARDS

It is NASA policy that space missions receiving funding from NASA comply with all international and United States regulations, standards, and agreements. Such regulations and standards include those promulgated by:

International Telecommunications Union (ITU)
National Telecommunications and Information Agency (NTIA)
Consultative Committee for Space Data Systems (CCSDS) [1]
Space Frequency Coordination Group (SFCG)

Information on the ITU and NTIA regulations can be obtained from the NASA Spectrum Management Office at the Lewis Research Center. Recommended standards for DSN, Ground Network, or TDRSS support can be obtained from Reference 5, the CCSDS home page.

1.5 SELECTION OF SERVICES

A SOMO Service Catalog (Reference 1) has been assembled, permitting users to select combinations of services ranging from full mission operations to basic telecommand and telemetry. Proposals should specify which services and tools they require from the list of standard services found in the catalog.

1.6 SOMO NON-CSOC SERVICES

SOMO continues to provide a class of services outside of the CSOC contract (Non-CSOC services). These services are provided directly by the NASA centers possessing the capability. Many of the available services are listed in the DSN service list in section 3 and the GSFC service list in section 4. Other NASA centers may offer services not listed in this document.

2.0 SOMO/CSOC SERVICE AND SUPPORT

Introduction

The SOMO Services Catalog provides the information necessary to enable a subscriber to order standard space operations services offered under CSOC, i.e., those services that a subscriber may select and which can be executed without the expenditure of non-recurrent engineering. Non-standard services (tailored services), i.e., those services with different functionality from the standard services and requiring new/modified capabilities with added implementation effort, are not contained herein, but may be requested through the service ordering process.

The Services Catalog contains the Services Ordering Process, points of contacts for assistance, and service descriptions of all standard services, and options available within each service. The services are classified into two basic categories: Mission Services and Data Services.

All information contained in Section 2 is available via the Internet at
http://www.csoconline.com/servicescatalog.htm

The following paragraphs list the services offered and a high level definition of the services.

2.1 MISSION SERVICES

Space Operations Mission Services are available to the subscriber in the following categories: Mission Planning, Mission Operations Services of Flight Operations, Flight Dynamics, and Science Data Processing; Data Storage Services; and Supporting Mission Services. Table 2-1 lists the Mission Services and a brief description of each service.

TABLE 2-1: CSOC MISSION SERVICE CATEGORIES

CSOC Service Category	Brief Description
Mission Planning Services	Mission Planning Services comprise the set of functions that provide coordination of preparation efforts for mission operations services. These services are offered for Mission Control Centers that may be internal as well as external to CSOC. The following is a list of products delivered under this service. These products can be selected at low, medium, and high intensity levels to meet mission needs: · Advanced Studies · Pre-launch Resource Planning · Post Mission Planning · Project Ground System Development Support
Ground System Services	Standard Ground System Services are offered for Solar System Exploration Missions only. These services are provided in support of flight project development and science operations activities. This service provides at a minimum 99.99% of processable data received from the DSN to flight project data storage and displays during critical periods and for critical data, 98% during non-critical periods. Inherent in providing this service is System Administration support, workstation maintenance, and the sustaining COTS software.

TABLE 2-1: CSOC MISSION SERVICE CATEGORIES

CSOC Service Category	Brief Description
Mission Operations Services	Standard Mission Operations Services are offered in the area of Flight Operations, Flight Dynamics, and Science Data Processing.
Flight Operations Services	Nine mission operations Flight Control Services provide the capabilities of command management, telemetry management, and ancillary services. Flight Control Services are provided for pre-launch, launch and checkout (spacecraft commissioning), and on-orbit operations phases.
Flight Dynamics Services	Thirty-execution phase Flight Dynamics services is offered to a subscriber in the form of standard products. Services are offered in ranges of performance with distinguishing characteristics provided below. Flight Dynamics services are divided into three main categories: · Navigation services, encompassing spacecraft trajectory determination and control, including trajectory design and maneuver planning, as well as supporting physical modeling · Attitude services, including spacecraft attitude determination and control, sensor modeling and calibration, and attitude reference modeling services · Launch trajectory services, involving real-time ascent-phase trajectory monitoring, acquisition support, and associated pre-launch preparations and simulations.
Science Data Processing	Science data processing is offered at graduated service levels to SOMO/CSOC customers. The levels of service take into account the robustness and degree of automation of the data processing system used as applied to the mission requirements.

TABLE 2-1: CSOC MISSION SERVICE CATEGORIES

Data Storage Services	The Data Storage service provides for the long-term storage, access, retrieval, and management of scientific and operational data for pre-mission, mission, and post-mission analysis, and reprocessing. Long-term data storage is defined as the storage of data for greater than 2 years.

TABLE 2-1: CSOC MISSION SERVICE CATEGORIES

CSOC Service Category	Brief Description
Supporting Mission Services	Twelve specialized services are offered to augment the standard mission operations services Negotiated on the basis of mission services requirements and anticipated subscriber needs, such services include consulting, training and instruction, test bed and simulation services, anomaly resolution support, and complete, delivered systems. The unit of service for these supporting services is a staff hour. If desired, an estimate based on specific negotiated mission requirements, and performance metrics can be provided for any of the specialized services. The following is a list of services offered. Service definitions and details of the services are listed in the Services Catalog. · Consulting Services · Training & Instruction Services · Test-bed and System Prototyping Services · Anomaly Resolution Services · Delivered System · System Operations Facility · Fallback Facility · Test Data Generation · Test Support Services · Flight Dynamics GS/Tracking Data Conversion Service · SDP/Operations Process Development and Documentation · Special Operations

2.2. DATA SERVICES

2.2.1

Data Services comprise telecommunications services (including standard network management services), special network management and data distribution services for earth-fixed, sub-orbital, orbital and deep space missions.

Telecommunication services are provided by several different networks each with its own customer focus and distinctive capabilities. These Telecommunication services are grouped as follows:

- Ground Network
- Space Network
- Deep Space Network
- Range Services
- Supporting Data Services
- Special Network Management Services
- Wide Area Network Services

2.2.2

The services that are separately priced for each network are unique. When obtaining a service and using a resource, all the capabilities of that resource are available to the subscriber. For example, if an antenna and associated systems are requested for return or telemetry service, the forward or command service and tracking service are also available to the subscriber and may be utilized without additional charge. It should be noted that the launch vehicle is considered as a separate customer from the payload (e.g., the customer spacecraft). Each separately subscribes to any data service.

For the Ground Network (GN), the service is dependent on the mission phase (launch or on-orbit), type of GN resource used (low latitude station or high latitude station) and subscriber type (sub-orbital, human space flight or unmanned). Low latitude stations are identified as having latitude of less than 60 degrees (***TBR***) and high latitude stations are identified as having latitude of 60 degrees and greater (***TBR***).

For the Space Network (SN), the service categories are based on several Customer Characteristics such as mission classification, the scheduling method and the support type.

For the Deep Space Network (DSN), the service categories are distinguished by the resource utilized (i.e., 70 Meter service, 34 Meter service, 26 Meter service, and 11 Meter VLBI service).

Details on the capabilities of each Network are provided in the Services Catalog.

2.2.3

Special Network Management Services, which are not already part of the standard network services, are provided upon customer request in terms of Scheduling, Real Time Control and Performance Monitoring, Customer Training and Customer Integration and Testing services. Table 2-2 lists the Data Services and a brief description of each service.

TABLE 2-2: CSOC DATA SERVICE CATEGORIES

CSOC Service Category	Brief Description
Ground Network Services	Ground Network (GN) services are provided to subscribers whose support falls into the following support categories: Launch, Sub-orbital, and Human Spaceflight On-Orbit; Unmanned On-Orbit Support from Low Latitude Station; Unmanned On-Orbit Support from High Latitude Station. Launch service pertains to expendable vehicle launches and early orbit support to the payload. Sub-orbital service includes support to aircraft, balloons, sounding rockets, missiles and drones. On-Orbit service includes support to LEO and GEO spacecraft. The Ground Network services contain Data Acquisition, Commanding, Tracking, Scheduling, Real-time Control and Performance Data Monitoring, and Testing. The following GN services are available for selection: · Launch, Sub-Orbital, and HSF On-orbit Service · Unmanned On-orbit Support from Low Latitude Station · Unmanned On-orbit Support from High Latitude Station · Unmanned On-orbit Support from the McMurdo TDRSS Relay System (MTRS)
Space Network Services	Three primary telecommunications resources are available from the Space Network (SN): single access (SA), multiple access return(MAR), and multiple access forward(MAF). These resources are used to deliver the services described in the Services Catalog. The cost of these SN telecommunication services depends on the subscriber's customer type and scheduling method. For certain services, the cost is also based on service request receipt time. The Space Network services contain Data Acquisition, Commanding, Tracking, Scheduling, Real-time Control and Performance Data Monitoring, and Testing The unit of service for all Space Network services is a minute of TDRS antenna time.
	Four types of SA services are available for selection. Detailed descriptions are listed in the Services Catalog. · SA On-Orbit, Constrained · SA On-Orbit, Flexible · SA On-Orbit, Near Real-time Residual · SA Terrestrial, Extra Capacity
	Three MA Forward and four MA Return Services are available for selection. Detailed descriptions are listed in the Services Catalog. · MAF/SMAF On-Orbit, Constrained · MAF/SMAF On-Orbit, Flexible · MAF/SMAF On-Orbit, Near Real-time Residual · MAR/SMAR On-Orbit, Constrained · MAR/SMAR On-Orbit, Flexible · MAR/SMAR On-Orbit, Near Real-time Residual · MAR 24X7 Random Access

TABLE 2-2: CSOC DATA SERVICE CATEGORIES

CSOC Service Category	Brief Description
Deep Space Network Services	Deep Space Network Services are offered at the 70 meter, 34 meter, 26 meter and 11 meter VLBI service levels. Inherent in providing Deep Space Network services are fundamental levels of Data Acquisition, Data Formatting and Transfer, Commanding, Tracking, Scheduling, Real-time Control and Performance Data Monitoring, and Testing. The unit of service for all Deep Space Network services is a minute of antenna support time. The calculation of the support time should include the Beginning of Track through End of Track time as well as the pre-pass setup time and post-pass activity time. The individual services associated with these DSN service categories are found in the Services Catalog. All DSN Tracking, Data Acquisition, Command (TDAC) services are purchased based upon the number of contacts expected with that resource per week. TMOD has determined, with NASA Headquarters concurrence, that a ***Weighted Pricing Algorithm*** shall be used for calculating ***DSN Aperture Fees*** in the full cost accounting era. This algorithm embodies incentives to maximize DSN utilization efficiency. It employs ***weighted hours*** to determine the cost of DSN support. The DSN base services are listed below. Detailed on the service descriptions, information on service units and determining pre- and post calibration times are provided in the Services Catalog. · Special Observation Science, 70M/34M · Tracking Data Acquisition and Commanding (70 M) Service · Tracking Data Acquisition and Commanding (34 M) Service · Tracking Data Acquisition and Commanding (26 M) Service · 11m VLBI Service

TABLE2-2: CSOC DATA SERVICE CATEGORIES

CSOC Service Category	Brief Description
Range Services	Below, is a general description of the capabilities of the Western Aeronautical Test Range at the Dryden Flight Research Center and the Wallops Flight Facility Test Range at the Wallops Flight Facility, Wallops Island, Va. These services are classified as range services and differ from those of the GN, SN, and DSN. Range services are typically used in support of sub-orbital vehicles but can support low earth orbit vehicles with limited capacity as well as aeronautical research and atmospheric sciences. The following is a general list of available services: **Western Aeronautical Test Range** · Radar Tracking · Telemetry Tracking · Air to Ground Communications · Flight Termination · Video · Long Range Optical Tracking · Mission Control Centers · Telemetry and Radar Acquisition Processing · Mobile Operations · Post-Flight Data Processing and Archival · Data Analysis **Wallops Flight Facility Test Range** · Telecommunications Services (UHF Command, Telemetry, and Communications) · Radar: Surveillance and Precision Fixed · Optical and Video Support · Meteorological · Range Control · Data Reduction

TABLE 2-2: CSOC DATA SERVICE CATEGORIES

CSOC Service Category	Brief Description
Special Network Management Services	The following services are offered under the Special Network Management Services:
Network Management Services	Certain necessary network management functions are performed inherent to delivering network services. These necessary network management functions are described in the Services Catalog for each of the Networks listed above, and are automatically included when obtaining command, telemetry or tracking service. In addition, Special Network Management Services are offered separately, as listed below. Detailed descriptions of the services and definition of units are provided in the Services Catalog. 2.0 Real-time Control and Performance Data Processing 3.0 Scheduling 4.0 Training
Customer Integration and Test Services	Subscribers may require tests in addition to the standard set for the specified network. Such tests can be requested through the integration and testing service. The subscriber will be provided with test planning, test execution, test reporting and fault analysis support. Associated data services are requested separately. Such tests may include engineering testing of portions of the final subscriber spacecraft or ground system. These tests may assist the subscriber in ensuring compatibility of all their systems' components with the network at early stages in development. End-to-end is generically intended to define activities that encompass (real-recorded, live, or simulated) spacecraft data input through a defined path to a defined end point (subscriber facility or network facility). The composition of the path and the endpoint largely depend upon the emphasis, objectives and complexity of the test activities. All of these tests are conducted and completed prior to initiation of the launch count. Any check-out activities that occur after initiation of the launch count are considered operations activities. End-to-end testing with non-SOMO facilities may be requested from the Special Network Management Services Integration and Testing Services via PSLA. The following services are offered under Customer Integration and Test Service. Each service is offered at three levels. · Customer Component Testing · Compatibility Test · Readiness Test · Launch Rehearsal

TABLE 2-2: CSOC DATA SERVICE CATEGORIES

CSOC Service Category	Brief Description
Compatibility Test Services	Compatibility test facility services are provided at two major CSOC locations within the United States. The CSOC development and testing facility (DTF-21), which is located near JPL in Altadena, California; offers compatibility test facilities for missions supported predominately by JPL and the DSN. The compatibility test laboratory (CTL), which is located at the GSFC in Greenbelt, Maryland; offers compatibility testing services for the missions and projects predominately supported by the GSFC and its associated tracking networks. Both centers offer compatibility services that can travel to a suitable testing site location provided by the service subscriber. A compatibility test trailer (or van) can be dispatched from either CSOC compatibility test center, to the subscriber's location or the spacecraft manufacturer's facility, where the unit is being produced. Both CSOC compatibility testing centers routinely support launch vehicle integration and "quick check" spacecraft compatibility testing, along with pre-launch and launch data flow support, from the Kennedy Space Center and the Cape Canaveral Air Force Station, in Florida. Six Compatibility Test Support Services are available for selection. · Compatibility Test Van · Compatibility Test Trailer · Compatibility Test Lab · DSN Testing Facility · Merritt Island Compatibility · Radio Frequency Simulation Operations Center
Wide Area Network Services (WAN)	The NASA Integrated Services Network (NISN) provides for the transport and delivery of NASA Wide Area Network (WAN) communications services. The NISN provides both digital and analog services, dedicated and switched circuits, packet data transport, multi-protocol wide area networking, domain name servers, and various data networks. Voice, video, and facsimile are also available. Brief descriptions of NISN services follow. Detailed descriptions can be found in the NISN Services Document (NSD) and in the SOMO Services Catalog.

3.0 JPL TMOD SERVICES, SUPPORT AND TOOLS

The Telecommunications and Mission Operations Directorate (TMOD), located at the Jet Propulsion Laboratory (JPL), is the program office responsible for operating the Deep Space Network (DSN) and the Advanced Multi-Mission Operations System (AMMOS). AMMOS and DSN facilities have been aggregated under the title of the Deep Space Mission System (DSMS). The DSN comprises a multiplicity of Earth stations and associated operating systems while AMMOS provides many mission related tools and services for: control, monitoring, orbit determination, data analysis, etc. These facilities are available for supporting Earth orbiting and deep space missions.

3.1 DEEP SPACE NETWORK

The DSN consists of control, communications, and test facilities at JPL, and Earth station complexes located near Goldstone, California; Canberra, Australia; and Madrid, Spain. Reference 5 contains a description as well as the specific characteristics of these stations.

The DSN provides communications services between spacecraft and Earth station complexes together with the ground communications among the complexes and the control center. Control for the network is located at JPL in Pasadena, California. Testing to establish compatibility between the spacecraft's Radio Frequency Subsystem (RFS) and DSN stations is available at the Development Test Facility (DTF-21) at JPL in Pasadena or by using the Compatibility Test Trailer (CTT) at a remote site. RFS compatibility testing is highly recommended and should be completed at least 18 months prior to launch.

DSN 26-meter, 34-meter, and 70-meter diameter antennas operating in the 2, 7, 8, and 32 GHz bands provide radio frequency communications. User costs vary with aperture size and utilization level (see equation 2-1). Generally, DSN services are included in the ***Aperture Fee*** (see Form 2-1 below). DSN 11-meter stations are designed for Very Long Baseline Interferometry (VLBI) missions and operate at 7, 8, and 15 GHz. Because of their limited capability, 11-meter stations are priced at a flat rate.

As a minimum, proposals should contain the set of telecommunications parameters in Table 2-1 and a list of required services taken from Table 2-3. While Proposers may or may not wish to use a tabular format, the required parameter values and service names should be supplied in a clear, concise, and readily apparent form. Table 2-2 is an example of a communications parameter table containing 20 parameter values in only 1/3 of a page.

3.2 ADVANCED MULTI-MISSION OPERATIONS SYSTEM

Main AMMOS elements are located at JPL; however, specific subsystems may also be placed at user sites. AMMOS offers users a selection of services for spacecraft command and control, data reduction and analysis, and navigation. TMOD services are integrated, and certain DSN services may be a prerequisite to obtaining AMMOS value-added services. Proposals should identify specific services (whether obtained from

AMMOS or other sources) listed in Table 2-3 required for mission support and the costs for each service over the life of the mission.

In addition to its standard services, AMMOS can provide users with specific software tools. Such tools include telecommand encapsulation and protocol verification, mission analysis software, spacecraft monitoring programs, and data analysis software. A list of available tools can be found in Table 2-5. Fees for AMMOS services and tools will vary with project requirements and costs must be based upon a user's needs. The information in Tables 2-3, 2-4, and 2-5 below may be used to generate rough estimates of AMMOS costs.

TABLE 3-1: REQUIRED TELECOMMUNICATIONS PARAMETERS AND DEFINITIONS

Parameter		Description
Maximum S/C Distance	Km	Maximum spacecraft-earth station distance during primary mission.
Encounter 1 Distance	Km	Maximum spacecraft-earth station distance during first encounter.
Encounter 2 Distance	Km	Maximum spacecraft-earth station distance during second encounter.
Encounter N Distance	Km	Maximum spacecraft-earth station distance during Nth encounter.
Uplink Transmitter Power	Watts	Earth Station Transmitter Output.
Uplink Frequency Band	GHz	Proposed earth-to-space frequency band expressed in GHz.
Uplink Transmitting Antenna	DBi	Gain (or name) of earth stations transmitting antenna (e.g., 34M BWG).
S/C Receiving Antenna Gains	DBi	Gains of all spacecraft receiving antennas.
Telecommand Data Rate	b/s	Maximum desired telecommand data rate.
Telecommand Bit-Error-Rate	-	Required telecommand Bit-Error-Rate (BER).
S/C Receiver Bandwidth	Hz	S/C Receiver's phase-locked-loop threshold bandwidth (2 Blo).
Turnaround Ranging	Yes/No	Statement whether turnaround ranging is required.
SC Transmitting Power	Watts	S/C Power amplifier Output.
Downlink Modulation Format	Name	Format name (e.g., PCM/PM/Bi-Ù, PCM/PSK/PM, BPSK, QPSK, etc.).
Downlink Frequency Band	GHz	Proposed space-to-earth frequency band expressed in GHz.
S/C Transmitting Antenna	DBi	Gains of all spacecraft transmitting antennas.
Downlink Receiving Antenna	DBi	Gain (or name) of earth station receiving antenna (e.g., 34M BWG) .
Telemetry Data Rate	b/s	Maximum desired telemetry data rate.
Telemetry Coding	Name	Telemetry code (e.g., convolutional, Reed-Solomon, concatenated, etc.).
Telemetry Bit-Error-Rate	-	Required telemetry Bit-Error-Rate (BER).

TABLE 3-2: SAMPLE TABLE FOR INCLUSION IN PROPOSAL

Parameter	Value	Parameter	Value
Maximum S/C Distance (km)		S/C Receiver Bandwidth (Hz)	
Encounter 1 Distance (km)		Turnaround Ranging (Yes/No)	
Encounter 2 Distance (km)		S/C Transmitting Power (Watts)	
Encounter N Distance (km)		Downlink Modulation Format	
Uplink Transmitter Power (Watts)		Downlink Frequency Band (GHz)	
Uplink Frequency Band (GHz)		S/C Transmitting Antenna Gains (dBi)	
Uplink Transmitting Antenna Gains (dBi)		Downlink Receiving Antenna Gain	
S/C Receiving Antenna Gains (dBi)		Telemetry Data Rate (b/s)	
Telecommand Data Rate (b/s)		Error Detecting-Correcting Code	
Telecommand Bit-Error-Rate		Telemetry Bit-Error-Rate	

3.3 TMOD SERVICES

TMOD offers an integrated set of AMMOS and DSN services. A detailed description of these services and their deliverables can be found in Reference 6 and 7. A service list and summary description appear in Table 2-3 below. Users can select only those services needed to support their project. However, some services require others to obtain or condition data before they are available.

TABLE 3-3: STANDARD TMOD SERVICES

Service Types	Brief Description
Command:	
Command Radiation	RF modulates and transmits CLTUs to user spacecraft.
End-to-End Command Delivery[1]	Error-free delivery of command files to spacecraft using COP-1 protocol (at 26M only).
Telemetry:	
Frame	Provides frame reconstruction and routing options for CCSDS compliant formats.
Packet	Extracts packets from frames by earth received time or sequence number.
Channel	Extracts data samples from packets based upon pre-established criteria.
Data Set	Provides Level-O products for selected instruments and observation cycles.
Mission Data Management:	
Short Term Data Retention	Data buffering and staging (up to 1-week) to ensure delivery.
Long Term Data Repository	Data storage and retrieval for life-of-mission.
Archive Product Preparation	Prepares data products for long-term data archival.
Experiment Data Products	Generates Level-1 experiment data.
Level 1 Processing	Generates Level-2 (or higher level) data products.
Higher Level Processing	Provides photoproduct enhancement and annotation at any level.
Photo Product	Adapt commercial technologies to man-machine interface for improved operations.
Sense of Active Presence	Science data visualization and animation using navigation, ephemeris, CAD, and
Science Visualization	remotely sensed data/imagery. 3D science data rendering and animation. Sense of Active Presence – virtual reality based on telemetry, science data, models, etc.
Archive Product Design	Interface with cognizant personnel of selected archive to define/design product.
Product Distribution	Distribution of data and science products, based on published/subscribed paradigm.
Compression Engineering	Design/select compression/decompression algorithms for specific instruments.
Tracking and Navigation	
Radio Metric Measurement	Provides raw, uncalibrated radio metric observables.
Validated Radio Metric Data	Validated, calibrated, radio metric data.
Orbit Determination	State vectors representing a solution obtained from conditioned data.
Trajectory Analysis	Flight path prediction, reconstruction, or optimization.
Maneuver Plan/Design	Provides maneuver analysis and design required for project planning.
Ancillary Data	S/C and planetary ephemeris and constants and instrument operational information.
Ephemerides	Ephemerides for planets, planetary satellites, comets and asteroids.
Modeling & Calibration	Provides terrestrial frame and transmission media calibration data.
Gravity Modeling	Harmonic gravity models for Moon, Mars, and Venus.
Cartography	Cartographic anchor points on surface of specific bodies.
Flight Engineering	
Spacecraft Health/Safety Monitor	Monitoring of spacecraft health based on project provided limits automated alarms.
Spacecraft Performance Analysis[2]	Provides system level performance analysis of spacecraft.
Telecom. Link Analysis	Planning, prediction, and performance analysis of S/C telecommunications link.
Spacecraft Time Correlation	Monitors S/C clock drift and correlates S/C time to a standard time reference.
Instrument Health/Safety Monitor	Provides instrument performance monitoring based on project provided limits.
Sequence Engineering[2]	Design, development, and execution of uplink process.
Science Observation Planning	Design and integration of target observations producing conflict-free timeline.
Radio Science	
Baseband Measurements	Transmission S-, X-, and KA-bands, open and closed loop signal capture.
Power Spectrum Display	Capture and partitioning of received signal into frequency bins containing amplitude.
VLBI	
Narrowband Measurements	Signal delay to 2 or more antennas based on narrowband signal.
Wideband Measurements	Signal delay to 2 or more antennas based on wideband signal.
Radio Astronomy	
Radio Astronomy in DSN Bands	I.F. signal distribution at 2, 8, and 32 GHz to special purpose equipment.
Radio Astronomy at Special Freqs.	I.F. signal distribution at special frequencies from 70-meter R & D cone.
Radar Science	
Continuous Wave	Transmission & reception of reflected continuous wave (CW) signal.
Binary Phase Coded	Transmission & reception of reflected CW signal modulated with binary sequence.
Interferometric Observations	Transmission & reception of reflected CW signal at multiple sites.
Ground Communications	
Ground Network	Provides data, voice, and video communications network services.
Data Transport	Low-latency UDP or Reliable Network Service (RNS) guaranteeing no lost packets.
Collaborative	Distributed file or computing services or videoconferencing between specific sites.

NOTES: 1. This service is not currently available but will be provided for missions launching in 2002.
2. This service is not currently available but will be provided for missions launching in 2003.

3.4 SERVICE COSTS

Caveat:
Cost numbers supplied in this Section are for planning purposes only. To ensure accurate application of this information and to validate cost estimates please contact a TMOD representative listed in Section 2.8. Upon request, TMOD will provide a cost estimate and letter of commitment. TMOD costs in Phase 2 proposals should always be validated by TMOD.

As NASA moves toward full cost accounting, it is important that proposals identify the pro-rata share of each service's cost. Users are free to select only those services that they require, but they also have the burden of estimating the costs for each of those services. The following information is intended to assist in estimating those costs.

3.4.1 DSN ANTENNA FEES

The algorithm for computing DSN ***Aperture Fees*** embodies incentives to maximize DSN utilization efficiency. It employs ***weighted hours*** to determine the cost of DSN support. The following equation can be used to calculate the ***hourly Aperture Fee*** (AF) for DSN support.

$$AF = R_B [A_W (0.9 + F_C / 10)] \quad (2\text{-}1)$$

where:

AF =weighted ***Aperture Fee*** per hour of use.

R_B =contact dependent hourly rate, adjusted annually ($607/hr. for FY00).

A_W =aperture weighting:

=0.80 for 26-meter or 34-meter High-Speed Beam Waveguide (HSB) stations.

=1.00 for all other 34-meter stations (i.e., 34BWG and 34 HEF).

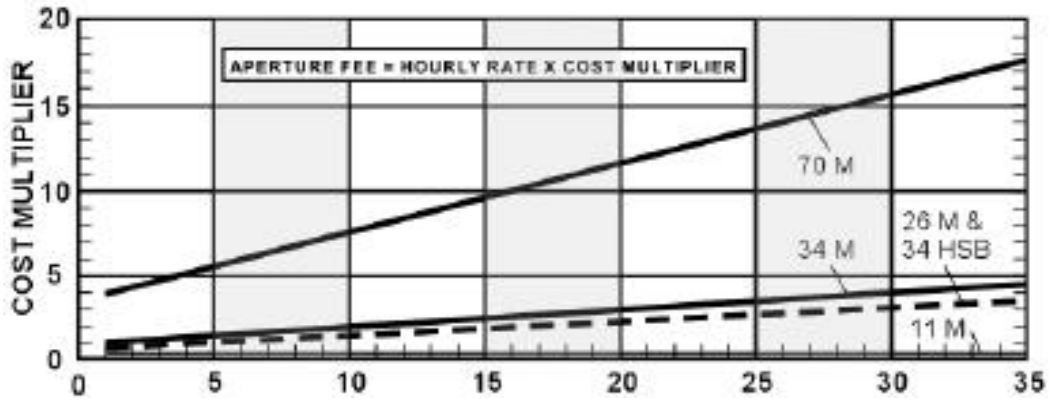
=4.00 for 70-meter stations.

F_C =number of station contacts, (contacts per calendar week).

The ***weighting factor*** graph (Figure 2-1) below shows relative antenna costs. It graphically illustrates the cost relationships between antennas and demonstrates the benefits of restricting the number of spacecraft-Earth station contacts each week.

A ***station contact*** may be any length but is defined as the lesser of the spacecraft's viewperiod, the scheduled pass duration plus calibration times, or 12 hours. A 45-minute precalibration and a 15-minute post calibration time must be added to each scheduled pass to obtain the ***station contact*** time.

FIGURE 3-1:APERTURE WEIGHTING FACTORS



Total DSN cost is obtained by partitioning mission into calendar weeks and summing the ***Aperture Fees***. This total cost can be computed by grouping weeks having the same requirement in the same year, multiplying by weighted ***Aperture Fee***, and summing over the mission's duration.

11-meter stations are designed to support Very Long Baseline Interferometry (VLBI) missions and have a very limited capability. VLBI missions are characterized by high data rates and nearly continuous Earth station support requirements. Therefore, the 11-meter station is charged at a flat rate of $0.2R_B$ irrespective of the number of hours that they are used each week.

A table entitled Form 2-1: ***DSN Mission Support Costs***, can be used to calculate DSN ***Aperture Fees***, and is on the following page. A personal computer program, running under Excel 2000, is available from the persons listed in Section 2.8 to compute the fee.

3.4.2 MULTIPLE SPACECRAFT SUPPORTED BY A SINGLE ANTENNA - FEE REDUCTION

Some programs, such as Mars, cluster a multiplicity of spacecraft in a single location. It may be possible to simultaneously capture telemetry signals from two or more spacecraft provided that they lie within the beamwidth of a single Earth station's antenna.

There are a few constraints. First, only one uplink frequency can be transmitted. In most cases, this means that only one spacecraft in the cluster can operate in the two-way coherent mode. The remainder must be in a one-way mode. Second, multiple, independent receivers are required at the Earth station. This sets a practical limit on the number of spacecraft that can be served simultaneously to 4. Third, ranging and two-way coherent Doppler data can only be obtained from the single spacecraft in a two-way mode.

If this situation applies and the constraints are acceptable, then it may be possible to reduce the Antenna cost for all spacecraft operating in this mode. To calculate the cost, first compute the ***Aperture Fee*** using equation 2-1 above. Thereafter, apply the correction factor according to the formula:

$$AF' = (0.75)\,AF \qquad (2\text{-}2)$$

where:

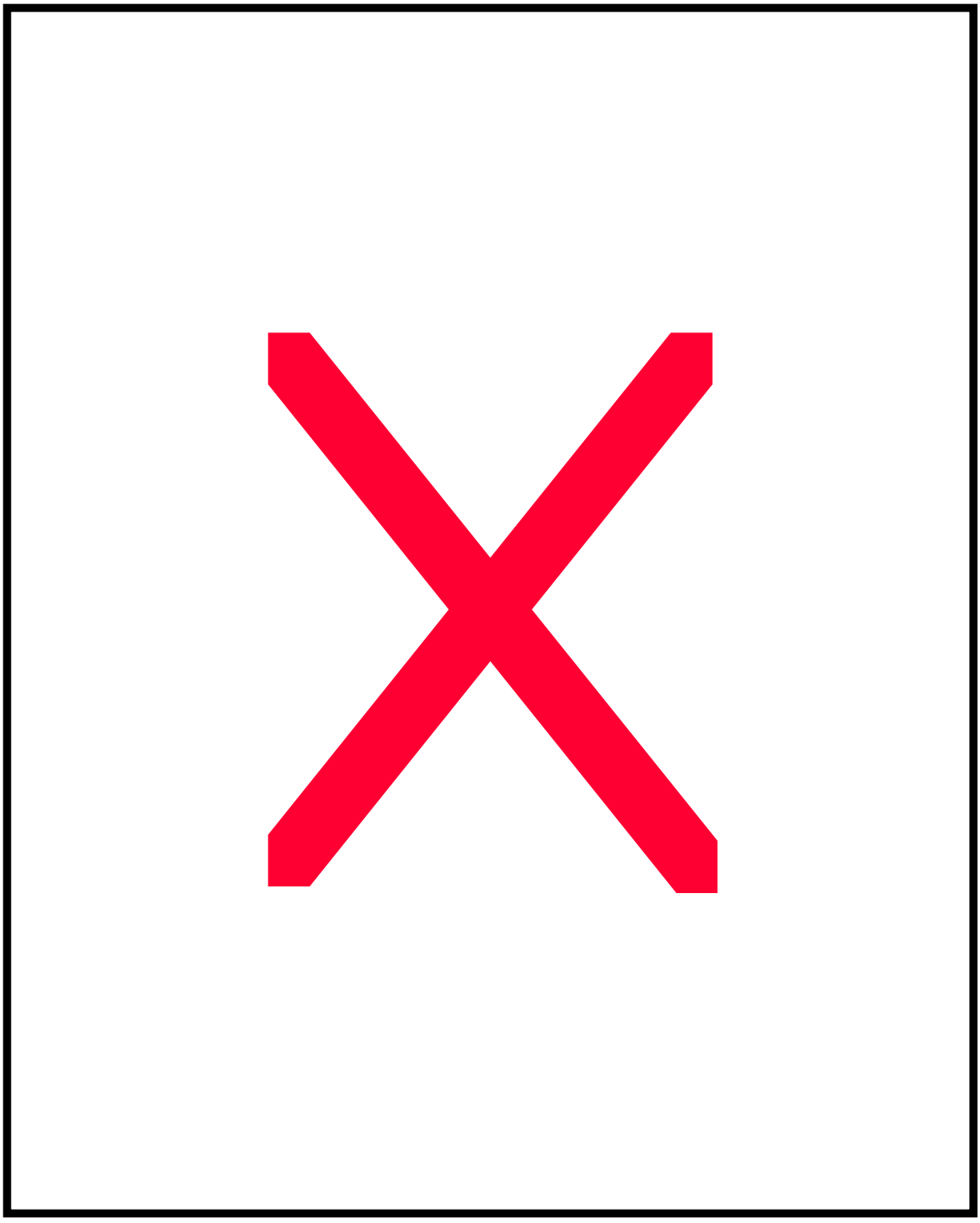
AF' = weighted ***Aperture Fee*** per hour of use when 2 or more spacecraft simultaneously share the same antenna.

The reduced price, AF', reflects the reduced capability available as a result of sharing. It assumes that the uplink and ranging capabilities will rotate through all spacecraft on a substantially equal basis.

3.4.3 COMPATIBILITY TESTING COST

TMOD encourages prelaunch compatibility testing as a means to eliminate post launch anomalies and expensive troubleshooting. TMOD maintains a facility known as the Development Test Facility (DTF-21) in Pasadena, California as well as a Compatibility Test Trailer (CTT). Except for not including a high power transmitter and a low noise-receiving amplifier, DTF-21 and the CTT are configured much like an operational DSN Earth station.

FORM 3-1: DSN MISSION SUPPORT COSTS



Approximately 18 months prior to launch, projects should to bring their Radio Frequency Subsystems (RFS) to DTF-21 (or use the CTT) for testing. Testing requires approximately two weeks and includes such items as RF compatibility, data flow tests, and transponder calibration.

Because TMOD believes that this testing materially improves the likelihood of success, no charge is made for the use of these facilities for a single set of compatibility tests. Rather, it is included in the hourly-dependent rate, R_B, used in Equation 2-1.

3.4.4 AMMOS FEES

TMOD has moved to a service based architecture. Only services required for support of each mission need be selected, minimizing the operations support costs for each project.

Note: Proposals should identify each specific service required for support of that project together with the number of units of that

Computing AMMOS services fees is more complex than DSN costs because each mission's requirements depend upon its specific objectives. Nevertheless, it is possible to estimate costs for some services. AMMOS service costs, C_S, comprise two components:

$$C_S = C_M + C_O \quad (2\text{-}3)$$

where:

C_M = Phase A and Phase C/D costs for hardware and software modifications.

C_O = Phase E mission operations costs for each service.

C_M represents a setup effort for preparing the AMMOS system to perform the service during the mission's operational phase. Setup costs include both labor and hardware components. Labor costs are expressed in ***Work Months*** (WM) corresponding to the effort of one person, possessing the requisite skill level, working for one month. Hardware costs are expressed in FY00 dollars. Preparation costs, $C_{M,}$ should be shown during the 2-3 year period before launch.

C_O is the incremental effort needed to perform the named service throughout the mission's operational phase (Phase E). Generally, C_O represents a labor cost. In Table 2-4, costs are expressed in FY98 dollars and should be adjusted to FY00 where $14.5K . 1 WM. C_O represents the service cost during the specified time interval, or the cost for the named capability. C_O appears as a Phase E service cost during each year that the service is provided.

Since the previous publication of this document, work has continued to refine service costs. Fees in Table 2-4 are based upon the most recent information and can be used as a guideline in proposal preparation. In an effort to simplify the process, costs are shown for the service category. Specific services in that category will be provided for that cost (e.g., a ***Packet Service*** is provided for the telemetry charge even though the ***Frame Service*** is required before packets can be extracted). AMMOS costs are separate and distinct from the aperture fees for DSN stations described above in Section 2.4.1.

TABLE 3-4: STANDARD TMOD MISSION SERVICES AND SUPPORT

Service Name	DSN Costs	Typical AMMOS Costs			
	Post-Launch	Pre-Launch		Post-Launch	
	Services In Aperture Fee	**Work Force (*Work Months)***	**Hardware *(FY98 $)*** [5]	**Work Force *(Work Months)***	**Support Cost *(FY98 $)*** [5]
Command:	Aperture Fee	9	$20K	0.5/Month	$100/Up-link Hour
Telemetry:	Aperture Fee	12	$40K	1.0/Month	$40/Dn-link Hour
Mission Data Management:	**Aperture Fee**	**16/Mission +**		**0.2/Month +**	**$7K/Month**
Short Term Data Retention	-	**0**	$40K + $1K/10 GB	0.5/Month	$7K/Month
Long Term Data Repository	-	1/Instrument	$40K + $1K/10 GB	0.1/Month	$2.5K/Inst./Month
Archive Product Preparation	-	4/Instrument	$40K + $1K/10 GB	0.2/Inst./Month	
Experiment Data Products:					
Level 1 Processing (Std. Inst.)	**Aperture Fee**	**8/Instrument** [1]	$25K	0.2/Month	-
Higher Level Processing	-	Min. 6/Instrument	$50K	0.4/Inst./Month	-
Photo Products	-	2/Instrument	$2.5K	0.1/Month	Media Cost
Sense of Active Presence	-	Min. 4/Instrument	Min. 10K	0.1/Inst./Month	-
Science Visualization	-	2/Visualization	$5K	0.1/Inst./Month	-
Product Distribution	-	0.5/Product	$5K	0.1/Inst./Month	-
Archive Product Design	-	3/Instrument	-	-	-
Archive Product Production	-	1/Inst. (Cal. Data)	-	0.2/Inst./Month	-
Compression Engineering	-	2/New Inst. Type	-		-
Tracking and Navigation: [2]					
Radio Metric Measurement	**Aperture Fee**	**-**	-	-	**-**
Validated Radio Metric Data	Aperture Fee	-	-	-	-
Orbit Determination	-	See	See	See	See
Trajectory Analysis	-	Reference	Reference	Reference	Reference
Maneuver Plan/Design	-	7	7	7	7
Ancillary Data	-		-		
Ephemerides	-		-		
Modeling & Calibration	-		-		
Gravity Modeling	-		-		
Cartography	-		-		
Flight Engineering:					
S/C Health/Safety Monitor	-	10	$50K	0.6/Month	-
S/C Performance Analysis	-	Call for Info.	Call for Price	Call for Info.	Call for Price
Telecom. Link Analysis	-	29	$50K	0.6/Month	-
S/C Time Correlation	-	5	$25K	0.1/Month	-
Inst. Health/Safety Monitor	-	15/Instrument	$50K	0.4/Inst./Month	-
Sequence Engineering:	**-**	**Call for Info.**	**Call for Price**	**Call for Info.**	**Call for Price**
Science Observation Plan:					
In-Situ Instrument Observe	**-**	10/Instrument	**$15K**	**1/Inst/Month**	**-**
Remote Sensing Instrument	-	2/Instrument	$15K	0.4/Inst./Month	-
Radio Science:	**Aperture Fee**	-	-	-	-
VLBI:	Aperture Fee	-	-	-	-
Radio Astronomy:	Aperture Fee [3]	-	-	-	-
Radar Science:	Aperture Fee [3]	-	-	-	-
Ground Communications:					
Data Communications	Aperture Fee [3]	-	-	-	-
Voice Communications	-	-	-	-	-
Video Communications	-	-	-	-	-
Data Transport	-	-	-	-	-
Collaborative	-	-	-	-	-

Notes:

1. **Antenna Fee = Service included in fee calculated from Section 2.4.1; 1 *Work Month (WM)* = 14.5K in FY 00 dollars;**
2. **Labor for standard instrument. Labor for more complex instruments will be a minimum of 14 Work Months.**
3. **Aperture costs only representative, for accurate costing please refer to equation in Reference 7.**
4. **Additional costs may accrue if new or special equipment is required to make the necessary measurements.**
5. **Costs contained in these columns are specified in FY 98 dollars and must be inflated to an appropriate year.**

3.4.5 COST CALCULATION

Total TMOD service cost is obtained by summing the DSN and AMMOS fees. DSN cost (***Aperture Fee, AF in $/Hr.***) is calculated by selecting a specific antenna and then determining the number and duration of tracking passes required to satisfy project navigation and science objectives. Each tracking pass must be increased in length by one-hour for calibrations. Once the pass length and number of passes is determined, multiply the aggregate hours by the hourly ***Aperture Fee*** computed using equation (2-1). A reduced cost is available when two or more spacecraft simultaneously share the same antenna (equation 2-2).

Total AMMOS costs are the sum of all service setup and incremental fees and depend upon the number and duration of the services required. Projects must first identify the specific AMMOS services that they need. They also need to determine the number of years, and fractions thereof, that these services will be required during the operational phase. Total Phase E cost for all services is calculated by multiplying the incremental fee for each service, found in the rightmost column of Table 2-4, by the total time that service is required and then summing over the set of services. Total Phase C/D expenses are labor plus hardware setup costs for each service summed over the set of services. Phase C/D costs should be distributed over a 2-3 period prior to launch.

AMMOS labor costs are stated in ***Work-Months*** to insulate the data from inflation factors. Users need only multiply the total number of ***Work-Months*** required for each service by the value for the year specified in the AO. For FY00, a burdened ***Work-Month*** is approximately $14.5K. Hardware and Phase E costs are shown in FY00 dollars and will need to be adjusted in order to be applicable to a different year.

3.5 AMMOS TOOLS AND COSTS

In addition to services, AMMOS can also provide users with tools needed to operate their mission. Tools are distinguished from services in that the former are software and hardware elements created for or adapted to a specific mission whereas the latter are those activities defined in Table 2-3 above. Tools are transferred to the flight project for operation by their personnel during the mission. Table 2-5 lists some AMMOS provided tools and includes a short description.

Because each mission is unique, it is difficult to provide apriori tool prices. Generally, AMMOS personnel need to confer with cognizant project personnel to determine specific tool requirements. Thereafter, it should be possible to quote a price for the product. If a tool’s specification can be completed by the end of Phase B, work can commence at the start of Phase C/D so that the tool will be available at launch.

3.6 GROUND COMMUNICATIONS COSTS

TMOD’s Ground Communications Facility (GCF) provides data lines between the several DSN complexes and JPL. NASA's Integrated Services Network (NISN) maintains communications lines among NASA centers and to institutions such as the European Space Agency’s control center, ESOC, in Darmstadt, Germany.

TABLE 3-5: TMOD PROVIDED MISSION OPERATIONS TOOLS [1]

TOOL NAME	TOOL FUNCTION
Command Command Delivery Automated Command Tracker	Command data encapsulation and uplink protocols conforming to CCSDS. Automated command file tracking, review, and approval process.
Telemetry	Turnkey telemetry system dedicated to acquisition, processing, monitoring, storage, and distribution of telemetry data (up to level-0), including CCSDS frame, packet, and channel services.
Mission Analysis Telecommunications Analysis	Monitor and predict the uplink and downlink telecommunications performance.
S/C Performance Analysis	Analysis capability for spacecraft and science instrument performance and health based upon telemetry data acquired from the various subsystems.
Mission Data Management Data Management	Data catalog, query, access, and data storage capabilities.
Data Products	Tools to create data products containing engineering and science data sets and to record them on a variety of magnetic and optical media.
Experiment Product Science Data Processing	Generates level 1A&B and higher level products from level-0 data.
Cartographic	Tools to support precise cartographic projections and elevation maps.
Science Data Visualization	Converts science data products for display or printing for visual interpretation.
Science product Delivery	Track and deliver file products to distributed Investigator sites.
Photo Product	Creation of photo products with visual enhancement and annotation.
Navigation Ancillary Data	Software supporting radiometric data conditioning, orbit determination, trajectory analysis, and maneuver planning and verification.
Mission Control	Displays engineering telemetry data to monitor spacecraft health and safety.
Instrument Control	Displays engineering telemetry data to monitor instrument health and safety.
Planning and Scheduling	
Sequence Planning	Provides sequence generation, validation, and review capabilities for standard mission commanding scenarios.
Test and Simulation	
Data Simulation Test	Generation of test data, i.e. simulated RF signals, spacecraft telemetry frames and packets, science data frames, and other data artifacts.
Spacecraft Simulation Test	Simulates spacecraft's behavior in response to control and external events.
Ground Data System	Both a full Test Telemetry and Command Subsystem (TTACS) and a miniature version of the entire GDS for support and development and test of spacecraft MOS.
Integrated Ground Data System	Provides turnkey system including computer platforms and a complete suite of tools adapted for mission specific needs.
Instrument Development Ground Support Equipment	Instrument Ground Support Equipment (IGSE) and environment software.
Flight Software Development	Tools and development environment for instrument software.
Instrument Modeling	Provides mathematical models of remote sensing instruments.
Calibration / Decalibration	Software supporting calibration analysis for science instruments.
Data Compression / Decompression	Selection and development of science data compression algorithms including end-to-end data system simulation – photon to final science product.

NOTE: 1. Contact TMOD service representative for Tool pricing information.

If service is required to a facility not now connected to the GCF or NISN, additional lines must be procured. Under full cost accounting, such additional common carrier fees must be acknowledged by the requesting project. In calculating line costs, users should determine the monthly cost, for a line of the needed capacity, from NISN's gateway at

MSFC to the desired location. That cost should be multiplied by the number of months that the special service is required. TMOD personnel can assist in obtaining costs.

3.7 TMOD REQUIREMENTS

The ***Standard Services*** architecture is intended to improve the efficiency of TMOD's operations and hence, to lower mission support costs to all of TMOD's customers. However, this architecture does impose a few constraints upon the users of TMOD's facilities.

3.7.1 USE OF STANDARDS

Missions seeking TMOD support must comply with international and United States regulations, standards and agreements. Such regulations, standards, and agreements include those published by the:

- International Telecommunications Union (ITU) (Reference 1)
- National Telecommunications and Information Agency (NTIA) (Reference 2)
- Consultative Committee for Space Data Systems (CCSDS) (Reference 3)
- Space Frequency Coordination Group (SFCG) (Reference 4)

3.7.2 TMOD SERVICES INTERFACE

Institutions wishing to transfer data to or from TMOD facilities should utilize a standard ***Space Link Extension*** (SLE) ***Services Interface***. The interface's architecture is based upon internationally adopted standards promulgated by the CCSDS. It will become operational on or before 1 October 2001 and missions launching after that date should plan to use this system. Additional information can be obtained by contacting the persons listed in Section 2.8.

3.7.3 X-BAND AND K_A-BAND COMMUNICATIONS

Projects operating in a ***Space Research*** allocation, which launch after 2003, should be designed to communicate in either the 7/8 GHz or 7/32 GHz bands. Both deep space and near Earth allocations exist in the 7/8 GHz band and should be used by future missions. Ever increasing congestion and the addition of allocations for incompatible services (e.g., IMT-2000) have made future operations in the 2 GHz band uncertain and, therefore, risky.

3.7.4 USE THE SMALLEST APERTURE AND THE LOWEST UPLINK POWER POSSIBLE

Designing a spacecraft to use the smallest DSN antenna possible increases the flexibility of TMOD's Scheduling function by permitting support of the mission with larger apertures if the requested station is unavailable. This maximizes the probability that the project will receive its requested coverage. Likewise, for missions requiring DSN 34M stations transmitting uplinks in the 7 GHz uplink band, designing the spacecraft to operate with a transmitter power # 4 KW permits the use of either the DSN's 34M BWG or 34M HEF stations.

3.7.5 USE OF FILE DELIVERY PROTOCOLS

Users should take advantage of the enhanced efficiency and operability facilitated by the use of the CCSDS emerging standards as well. The CCSDS Proximity-1 Space Link Protocol (currently in Red book form) provides in-situ users with standard formats, procedures, and qualities of services for bi-directional data transfer. The CCSDS File Transfer Protocol (CFDP) can be layered on top of Proximity-1 to provide both bi-directional file and message transfer between in-situ users as well as deep space – Earth transfers. Reference 8 describes to protocol and can be viewed on the CCSDS home page: http://www.ccsds.org/red_books.html.

3.8 ASSISTANCE WITH MISSION DESIGN

Prospective TMOD service users can obtain additional information about TMOD's services and capabilities by consulting Reference 6 below or by contacting the Future Missions Planning Office in TMOD's Plans and Commitments Office. TMOD's Future Missions Planning personnel can assist individuals preparing proposals by: identifying future capabilities and services, preparing a preliminary communications link analysis, describing TMOD requirements placed on users of its facilities, and assisting in the preparation of cost estimates for TMOD services. For such support please contact one of the persons listed below:

Warren L. Martin Manager, TMOD Future Missions Planning Office Jet Propulsion Laboratory 4800 Oak Grove Drive M/S 303-402 Pasadena, CA 91109 Phone: (818) 354-5635 FAX (818) 393-1692 e-mail: warren.l.martin@jpl.nasa.gov	Greg J. Kazz Systems Engineer, TMOD Future Missions Planning Office Jet Propulsion Laboratory 4800 Oak Grove Drive M/S 303-402 Pasadena, CA 91109 Phone: (818) 393-6529 FAX (818) 393-1692 e-mail: greg.j.kazz@jpl.nasa.gov	Edward Luers Systems Engineer TMOD Future Missions Planning Office Jet Propulsion Laboratory 4800 Oak Grove Drive M/S 303-402 Pasadena, CA 91109 Phone: (818) 354-8206 FAX (818) 393-1692 e-mail: edward.b.luers@jpl.nasa.gov

4.0 GODDARD SPACE FLIGHT CENTER (NON-CSOC) SERVICES

4.1 INTRODUCTION

This section describes GSFC Non-CSOC mission and data services. They are: Operations and Data Systems Engineering Consultation, Flight Dynamics, Flight Software (FS/W), and Data Services.

GSFC offers expertise and elements in Earth and space science missions to achieve new approaches to operations, including technology first use infusion and mission unique adaptation of existing systems. These services are provided by GSFC civil servants and/or Non-CSOC contractors.

Service costs range in proportion to mission complexity and data requirements. Pricing of services is available through the GSFC Center Customer Commitment Manager (CCCM):

Jon Z Walker
Jon.Z.Walker.1@gsfc.nasa.gov
(301) 286-7795

4.2 OPERATIONS AND DATA SYSTEMS ENGINEERING CONSULTATION

Operations and data systems engineering consultation offers system services and mission operations services providing evolutionary capabilities to plan launch vehicle, spacecraft, payload, ground system, and network activities for the conduct of mission operations.

These services provide the operations concepts and data systems architectures (flight and ground) for new mission studies and proposals. These services also assist the subsequent definition of a successful mission through development of mission concepts and requirements appropriate to the mission and budget objectives and constraints in the Announcement of Opportunity or other project formulation directions. In the process of developing mission concepts, it is necessary that conceptual services and associated mission/flight segment operating parameters be reconciled to ensure that a valid concept has been identified. Mission forecasting services provide the analysis to assess system capacity and capability to support new mission requirements, including tracking station loading studies.

Engineering consultation is provided to plan and implement MOC functions, for example, planning and scheduling, command management, level zero processing (LZP), real-time health and safety, and anomaly investigation. Other engineering consultation mission services include ground system I&T, trending, and science data processing.

4.2.1 TOOLS

Tools used in support of this service area include:
Requirements development/traceability –Requirements Generation System (RGS)
Tracking station loading studies – Network Planning and Analysis System (NPAS)
Planning and scheduling- Mission Operations Planning and Scheduling System (MOPSS), UPS (User Planning System for Scheduling TDRSS), FORMATS (Interface between Flight Dynamics and Command Management), SPIKE, ROSE
Command management - TBS
LZP – PACOR II and DPS
R/T H&S – ASIST and ITOS
Trending – GTAS (Generic Trending and Analysis System)
Science data processing - TBS
Ground system I&T – ASIST and ITOS

4.3 FLIGHT DYNAMICS

Flight dynamics services provide development of new flight dynamics orbit/attitude determination and control algorithms; advanced navigation techniques and mission design techniques; development of reference models used for flight dynamics support (star catalogs, atmospheric density models); new concepts for spacecraft autonomy (ground and onboard); and advanced technologies associated with distributed spacecraft.

4.3.1 MISSION DESIGN, ANALYSIS, AND MODELING SERVICES

Mission Design services provide support to feasibility study teams and potential principal investigators in developing new mission concepts. This consists of developing new and innovative orbits and trajectories to meet science requirements. Studies include the development of new and improved trajectory design techniques for libration point orbits (e.g., manifold theory) and improved targeting and control methods for a variety of mission concepts (e.g., dynamical systems, solar sail techniques). This service provides navigation error analysis, attitude error analysis (evaluation of sensor complements), trade-off studies for autonomy, preliminary fuel budgets and other guidance, navigation and control (GNC) system evaluations. The end product of this effort is often a mission feasibility report and/or material for mission proposals.
This service also provides analysis for sensor performance, anomalies, and modeling for a wide variety of current and future missions. Studies include a new compilation of Earth sensor performance data, and evaluation of albedo effects with respect to various sun sensors. In addition, this service provides consultation on general issues and analysis of in-flight attitude sensor performance. This service also includes specialized support to develop, maintain and enhance solar flux models and star catalogs required for support of operational missions and future missions.

4.3.2 NAVIGATION, FORMATION FLYING, AND AUTOMATION TECHNIQUES

Onboard navigation techniques and systems development services provide new capabilities and improve upon existing autonomous navigation capabilities. Studies include the use of traditional communications and tracking capabilities (e.g., SN, GN) and subsystems (e.g., transponders, command receivers) to provide an autonomous navigation capability, and the use of GPS to provide precision real-time orbit determination capabilities in support of highly capable, low cost/weight/power space-borne GPS receivers. This service also includes the development of techniques to support autonomous navigation for non-LEO missions (e.g., HEO, libration point, deep space).

Autonomous maneuver decision making, planning, and execution techniques are being extended to enable distributed networks of individual vehicles to interact with one another and act collaboratively as a single functional unit which exhibits a common system wide capability. This service focuses on the development of techniques and subsystems which enable the relative positions and orientations of vehicles to be determined; development of formation flying control architectures, strategies, and management approaches; development of inter-spacecraft communication techniques and subsystems; and the assessment of ground/flight operations concepts, trades, and accommodation requirements.

This service also provides resources, facilities, and technical direction and oversight to support and focus the efforts of government, academic, and industry partners working towards the implementation of lights-out flight dynamics product generation. This service attempts to accomplish this by encouraging initiatives across several different technology focus areas: (1) the application of existing technologies (e.g., expert systems); (2) the application of state of the art technologies (e.g., genetic algorithms); (3) the development of fundamentally new approaches to these functions; and (4) the development of "smart" tools which promote, facilitate, and contribute to non-human operations.

4.3.3 ADVANCED ATTITUDE DETERMINATION AND CALIBRATION

This service offers advanced attitude determination and calibration techniques and tools in response to the needs/requirements of the next generation Earth and Space sciences campaigns and missions. These studies include the development of attitude techniques to support improved autonomous attitude determination and the development and validation of alternative attitude determination techniques and improved attitude sensor and control law calibration techniques.

4.3.4 FLIGHT DYNAMICS TOOL DEVELOPMENT

This service supports the development of advanced flight dynamics tools. These tools support GN&C attitude estimation and analysis, attitude control system analysis and design, orbit estimation and analysis, and mission analysis and design. GN&C Flight

Dynamics Tools activities are conducted in direct response to customer (Earth Sciences Enterprise, Space Sciences Enterprise, Human Exploration and Development of Space Enterprise) requirements. These tools are required in support of all aspects and phases of mission formulation, design, implementation, and operations. These tools are also required in support of the flight dynamics technology development activities associated with the Guidance, Navigation and Control Center (TBR).

4.4 FLIGHT SOFTWARE (FS/W)

4.4.1 FS/W ENGINEERING CONSULTATION

Flight Software system services include access to mission-unique flight software engineering expertise to be applied toward flight software concept definition, development, health and performance evaluations, anomaly strategies, special operations (e.g., reboost) preparations and executions, and flight resource management. These subsystem specialists provide consultation to operations and development staff.

4.4.2 FS/W TOOLS

Hybrid Dynamic Simulator (HDS), Simulation System, OBC Load and Dump Tools, Flight Software Requirements Generation Tool. Other (TBD)

4.5 DATA SERVICES

4.5.1 RF SYSTEMS ENGINEERING ANALYSIS AND SUPPORT

GSFC Code 450 provides RF communications systems engineering service to independently evaluate and assess future network planning activities including commercially available services. Code 450 performs the following network planning support services: future network performance evaluations, research and development planning analyses and support, network system requirement, design and modification analyses, user guideline support and evaluations, and network impact assessments.

Code 450 provides RF systems engineering, design and analysis expertise for evaluating end-to-end communications and tracking architecture and performance for missions supported via the Space Network, Ground Network, Deep Space Network, AFSCF, other international assets, and customer dedicated terminals. Code 450 provides GSFC in-house communication and tracking support to all earth science and space science flight missions. The services provided by GSFC Code 450 include performing independent systems engineering analysis and evaluation in support of future mission related activities. These services include performance and compatibility analyses; RF terminal design assessments and optimization analyses; interference analysis; and new technologies evaluations (advanced modulation, coding and filter design). These analyses will utilize advanced systems engineering tools such as:

CAGE, SPW, PNAT and ARPAS. Customers include: launch vehicles, sub-orbital missions, and space missions .

4.5.2 SPECTRUM MANAGEMENT

Code 450 provides spectrum management services for all the space science and earth science projects within GSFC, and to services supported by NASA space and ground networks and other customers. These services include: the selection of quality spectrum in accordance with national and international allocations and service requirements and authorizations; obtaining federal government certification and frequency authorization license for all GSFC transmitters and receivers; obtaining radio frequency interference protection on a national and international level; protecting spectrum interests of the space and ground networks and their users; performing any required interference analysis (such as power flux density, co-channel interference, and out-of-band emissions) and coordinate requests for frequencies through the Glenn Research Center.

4.5.3 MATH MODELING

GSFC Code 450 services include developing analysis and simulation models using CAGE, SPW, MathCad, and MatLab to support GSFC in assessing flight project communication link performance. Code 450 provides quantitative results to support network and flight projects' ability to make timely decisions regarding the project's implementation concerns such as: performance requirement budget allocations; requirement non-compliance assessment; requirement waiver request evaluations; and post-events performance irregularities identification. The development of computer models to perform this service includes: evaluating communication requirements; evaluating end-to-end communication subsystem architecture design; developing simulation and analysis models; performing analysis using these models to assess performance; and comparing simulation results with testing results.

5.0 NASA INTEGRATED SERVICE NETWORK

5.1 INTRODUCTION

The NASA Integrated Services Network (NISN) provides for the transport and delivery of NASA Wide Area Network (WAN) communications services. The NISN provides both digital and analog services, dedicated and switched circuits, packet data transport, multi-protocol wide area networking, domain name servers, and various data networks. Voice, video, and facsimile are also available. Brief descriptions of NISN services follow. Detailed descriptions can be found in the NISN Services Document (NSD).

5.2 VIDEO SERVICES

Table 5.1: Video Services

Service ID	Service Title	Unit of Service
2.7.1.01	Video Teleconferencing Service (ViTS) Room Equipment	Avg. Cost/System
2.7.1.02	Video Teleconferencing Service (ViTS) Room Maintenance*	Room per month
2.7.1.03	Low Bandwidth Video Service (LBV) Room Equipment	Avg. Cost/System
2.7.1.04	Low Bandwidth Video Service (LBV) Room Maintenance*	LBV Unit per month
2.7.1.05	Video Distribution Service	Minute
2.7.1.06	Occasional Use Video	Annual/Unit
2.7.1.07	HRDVS for Space Shuttle	Annual/Unit

* The usage cost ($/min) of ViTS and LBV Conferences is included in the FTS Bills from GSA that are sent to the centers for payment.

5.2.1 Video Teleconferencing Service (ViTS): Room Equipment/ Maintenance

The NASA ViTS is a video teleconferencing service providing interactive point-to-point and multi-point conferencing capabilities to NASA locations, selected contractor facilities, and public video conferencing services. The ViTS services include provisioning and maintaining of special video conferencing rooms, scheduling of video conferences, and the transmission and distribution of the video, audio, and graphics among the participating locations.
The ViTS is currently based on circuit-switching technology and utilizes signal and content compression techniques to enable operation at 384 kb/s.
The ViTS rooms consist of multiple cameras, an audio conferencing system, projection screens, and static image graphics capture equipment.
Translation among several standard compression formats and speeds is available.

5.2.2 Low Bandwidth Video Service (LBV) Room Equipment/ Maintenance

The NASA LBV service is a video teleconferencing system providing interactive point-to-point and multi-point conferencing capabilities to NASA locations, selected contractor facilities, and public video conferencing services. LBV services include provisioning and maintaining portable room systems designed for use by smaller groups, scheduling of teleconferences, and the transmission and distribution of the video and audio among the participating locations.

The LBV is currently based on circuit switching technology and utilizes signal and content compression techniques to enable operation at 112-128 kb/s as the standard mode. Translation among several standard compression formats and speeds is available.

5.2.3 VIDEO DISTRIBUTION SERVICE

The NISN Video Distribution Service provides for the distribution of video signals in support of NASA programs. The particular implementation is dependent on the specific requirements of the program and may involve terrestrial or satellite transmission, with or without the utilization of digital compression and encoding techniques.
This service supports the distribution, on a point-to-point, point-to-multi-point, or satellite broadcast basis, of video signals in support of NASA programs and mandates. This service supports spaceflight mission launch activities as well as distribution of NASA programming to the public.

5.2.4 OCCASIONAL USE VIDEO

NISN will provide Broadcast Quality Video service between virtually any locations in the world. Video service can be provided as a point-to-point configuration between two locations or as a satellite broadcast configuration between multiple locations. Service can be obtained for short periods, e.g., a few hours per day for a few days, or for longer periods, e.g., full-time (24 x 7) dedicated use over an extended period of time.

5.2.5 HIGH RATE DATA/VIDEO SERVICE

This service provided by NISN is limited to STS users only. The HRDVS is a service that allows the user to receive Ku band high rate STS data via the 50 MB Statistical Muliplexer system, STS analog data or STS vehicle video. The source of this interface is the White Sands Complex.

5.3 VOICE SERVICES

5.3.1 VOICE TELECONFERENCING (VOTS)

Table 5-2: Voice Teleconferencing Services (VoTS*)*

Service ID	Service Title	Unit of Service
2.7.2.01	VoTS Small conference room provisioning	Avg. Cost/System
2.7.2.02	VoTS Large conference room provisioning	Avg. Cost/System
2.7.2.03	VoTS Usage-Operator Assisted	Cost/Minute
2.7.2.04	VoTS Usage- Dial In	Cost/Minute

The NASA VoTS provides for the audio meeting and conferencing needs of the Agency. The VoTS provides for the scheduling and setup of operator initiated or toll-free dial-in conferences. This service also includes the provisioning and maintaining of room audio conferencing systems.

Two room provisioning services are available for selection and shown in Table 5-2 above. The unit of service is the actual room price and is a one time charge.

Two Voice Teleconferencing Services are available for selection and shown in Table 5-2 above. The unit of service for VoTS conference room provisioning is the average cost per system. The unit of service for VoTS usage is based on a per minute charge.

5.3.2 DEDICATED VOICE SERVICE

Table 5-3: Dedicated Voice Services

Service ID	Service Title	Unit of Service
2.7.2.05	Dedicated Voice Local (<25 miles)	**Service Month**
2.7.2.06	Dedicated Voice Domestic (>25 miles)	**Service Month**

Dedicated Voice service encompasses a wide range of services and service complexity. At its simplest, it can be a dedicated point-to-point “shout down” circuit with no signaling. However, the majority of Dedicated Voice services consist of a system of highly reliable, dedicated voice circuits working in conjunction with a switching and conferencing system to create voice loops. These voice loops interconnect the various voice distribution systems that support the various mission control centers within the Agency. The unit of service for Dedicated Voice services is a service month.

5.3.3 LONG DISTANCE SWITCHED VOICE SERVICE

Table 5-4: Long Distance Switched Voice Service

Service ID	Service Title	Unit of Service
2.7.2.07	Long Distance Switched Voice Service	**Usage-based**

** The usage cost ($/min) of long distance switched voice Service is included in the FTS Bills from GSA that are sent to the centers for payment.

NASA’s long distance telephone requirements are provided under this service. The service provides both domestic and international long distance dialing services for NASA and selected contractor personnel and includes the provisioning of toll-free inbound (800/888 numbers) and calling card services. The unit of service for Long Distance Switched Voice service is institutional.

5.4 FACSIMILE SERVICES

Table 5-5 Facsimile Services

Service ID	Service Title	Unit of Service
2.7.3.01	Facsimile Service - Maintenance	Machine per Month
2.7.3.02	Facsimile Service - New Machine	Max per Machine

Table 5-5 Facsimile Services

Service ID	Service Title	Unit of Service
2.7.3.03	Facsimile Service - Broadcast Service	Subscription Rate/Month
2.7.3.04	Facsimile Service - Lease Arrangement	Machine per Month

Facsimile services include facsimile machines, secure facsimile machines, facsimile machine maintenance, a broadcast facsimile capability and facsimile service leasing. The Facsimile Service – New Machine and Facsimile Service – Maintenance services include the centralized procurement and maintenance of facsimile machines in support of all NASA programs. Facsimile Broadcast service provides the capability for NASA users to send a document to multiple recipients, as established on a preset distribution list, via a single transmission. Facsimile Service – Lease Arrangement service provides for lease arrangements of facsimile machines. Secure facsimile machines designed to interface with cryptographic devices and meet National Security policies are available by special arrangement. The unit of service for Facsimile services is either a machine or subscription rate per month.

5.5 ROUTED DATA SERVICE

This service provides for basic data networking connectivity through the use of the Internet Protocol suite (IP). Services are provided in units of 56/64 Kbps, 1536 Kbps,10 Mbps and 43 Mbps. The basic units are for network access and do not include cost for tail circuits. To provide services off site from the NASA centers a tail circuit charge will be made.

5.5.1 STANDARD ROUTED DATA

Table 5-6: Standard Routed Data Services

Service ID	Service Title	Unit of Service
2.7.4.01	Standard Routed Data, n*64 Kbps	**Units Month**
2.7.4.02	Standard Routed Data, n*1544 Kbps	**Units Month**
2.7.4.03	Standard Routed Data, n*10 Mbps	**Units Month**
2.7.4.04	Standard Routed Data, n*45 Mbps	**Units Month**

Standard IP service is the commodity Internet service that provides the Agency's link to the Internet in general. It provides basic universal Internet connectivity with minimal performance guarantees or restrictions on acceptable use. Standard IP service is open to the public to access publicly available NASA information sources such as World Wide Web services. The unit of service for Standard Routed Data services is a unit month.

Agency policy dictates the use of IP as the Agency standard protocol for data networking. Other protocols are supported on a legacy basis only.

5.5.2 PREMIUM ROUTED DATA

Table 5-7: Premium Routed Data Services

Service ID	Service Title	Unit of Service
2.7.4.11	Premium Routed Data, n*56/64 Kbps	**Unit Month**
2.7.4.12	Premium Routed Data, n*1536 Kbps	**Unit Month**
2.7.4.13	Premium Routed Data, n*10 Mbps	**Unit Month**
2.7.4.14	Premium Routed Data, n*43 Mbps	**Unit Month**

This service provides a premium level of data networking connectivity through the use of the Internet Protocol (IP) suite.
Premium IP service is differentiated from standard IP service in that it provides a higher performance level, higher priority for problem resolution, and is not directly connected to the general Internet. Premium IP connectivity to the general Internet is through a controlled gateway and is implemented on an exception basis only.
Premium IP service is most appropriate for internal Agency networking requirements where the Agency's operations should be isolated from the general Internet. Agency policy dictates the use of IP as the Agency standard protocol for data networking. Other protocols are supported on a legacy basis only. The standard unit of service for Premium Routed Data services is a unit month.

5.5.3 MISSION CRITICAL ROUTED DATA

Table 5-8: Mission Critical Routed Data Services

Service ID	Service Title	Unit of Service
2.7.4.21	Mission Critical Routed Data, n*64 Kbps	**Unit Month**
2.7.4.22	Mission Critical Routed Data, n*1544 Kbps	**Unit Month**
2.7.4.23	Mission Critical Routed Data, n*10 Mbps	**Unit Month**
2.7.4.24	Mission Critical Routed Data, n*45 Mbps	**Unit Month**

This service provides a mission critical level of data networking connectivity through the use of the IP suite with very controlled access and security measures.

Mission Critical IP service is differentiated from standard IP service in that it is engineered as a very closed system to support spaceflight mission critical telemetry and data flows. All systems and facilities connected to the Mission Critical IP service must meet the specified Information Technology security level. Access to and from the general Internet and other NASA IP services is extremely limited and on a strict exception basis only.

Mission Critical IP service is most appropriate for critical spaceflight mission support data and telemetry flows that require an extremely high level of availability for mission

success and that require no general Internet access. Agency policy dictates the use of IP as the Agency standard protocol for data networking. Other protocols are supported on a legacy basis only. The unit of service for Mission Critical Routed Data services is unit month.

5.5.4 REAL-TIME CRITICAL ROUTED DATA SERVICE

Table 5-9: Real-time Critical Routed Data Services

Service ID	Service Title	Unit of Service
2.7.4.31	Real-time Critical Routed Data, n*56/64 Kbps	**Unit Month**
2.7.4.32	Real-time Critical Routed Data, n*1536 Kbps	**Unit Month**
2.7.4.33	Real-time Critical Routed Data, n*10 Mbps	**Unit Month**
2.7.4.34	Real-time Critical Routed Data, n*43 Mbps	**Unit Month**

This service provides a mission critical level of data networking connectivity with emphasis on meeting real-time telemetry transport through the use of the IP suite. Real-time Critical IP service is primarily differentiated from Mission Critical IP service in that it is engineered with a high level of redundancy to achieve the added level of availability. This service employs the same security and connectivity features and limitations as the Mission-Critical service. Agency policy dictates the use of IP as the Agency standard protocol for data networking. Other protocols are supported on a legacy basis only. The unit of service for Real-time Critical Routed Data services is unit month.

Table 5-10 IP Service and Performance Parameters

Service	Availability	Restoral Time	Coverage Period	Acceptable Packet Loss	Round Trip Time (TBR)
Real-time Critical	99.98%	<1 minute	24X7	.001%	<120 ms
Mission Critical	99.95%	2 Hours	24X7	.001%	<120 ms
Premium	99.5%	4 Hours	24X7	<1%	<100 ms
Standard	99.5%	<24 Hours	6 AM Eastern to 6 PM Pacific M-F	1%	<250 ms

5.5.5 ROUTED DATA TAIL CIRCUIT

Table 5-11: Routed Data Tail Circuit

Service ID	Service Title	Unit of Service
2.7.4.41	Routed Data tail Circuit, n*56/64 Kbps	**SOMO Quote**
2.7.4.42	Routed data tail Circuit, n*1536 Kbps	**SOMO Quote**
2.7.4.43	Routed Data tail Circuit, n*10 Mbps	**SOMO Quote**
2.7.4.44	Routed Data tail Circuit, n*43 Mbps	**SOMO Quote**
2.7.4.45	Routed Data tail Circuit Installation Charge	**SOMO Quote**

A routed data tail circuit is required to provide access from a location remote from one of the NASA centers or NISN Hubs . An access requiring a tail circuit may also limit the available IP service to premium or standard based on local providers capabilities. The price for the routed data tail circuits are developed based on individual mission requirements. The individual requirements and pricing for this service are to be coordinated with the CSOC CSR.

5.5.6 CUSTOM DATA DISTRIBUTION SERVICES

Custom telecommunication and networking services are specifically designed and engineered to meet unique NASA programmatic requirements. Each program determines the unique attributes of the data distribution services in such terms as security, availability, redundancy, and features that provide the optimum trade-off between cost and program success.

Custom Services as shown in table 5-12, may be used both for spaceflight mission critical applications and for general administrative support requirements possessing unique attributes. These services are customized for each individual client and therefore priced based on the individual service requirements. The unit of service for Custom Data Services is either the actual cost or staff hour.

Table 5-12: Custom Data Services

Service ID	Service Title	Unit of Service
2.7.5.01	Dedicated Data Category	SOMO Quote
2.7.5.02	International Service	SOMO Quote
2.7.5.03	Integration and Consulting Service	Staff Hour
2.7.5.04	Custom Service	SOMO Quote
2.7.5.05	Globally Interconnected Advanced Networked Telepresence (GIANT)	SOMO Quote

5.6 DEDICATED DATA

Each dedicated data service is a customized assessment for an individual client requirement. The price for the dedicated data service is developed based on individual mission requirements. The individual requirements and pricing for this service are to be coordinated with the CSOC CSR.

5.6.1 International Service

International data distribution services are provided to many of NASA's International Partners and agencies through cooperative arrangements. Rather than purchase dedicated circuits for each requirement, cooperative consolidation and integration of various requirements into an economical infrastructure provide the basic connectivity for programmatic requirements for the transport of data, voice, facsimile, electronic mail, and video.

To the greatest extent feasible and economical, these gateway and consolidated circuits support all other data distribution services otherwise enumerated.

5.6.2 Integration and Consulting Service

Whether a subscriber's requirement is as small as a simple data link between two points or as complex as a dedicated sub-network for a specific project, consulting and integration services are available to provide the subscriber with one-stop shopping for the satisfaction of communication and network requirements. If the requirement is unique or does not easily fall within standard service offerings, consulting staff is offered to work with the subscriber to provide a tailored solution to the unique needs of a project.

Examples of available service include:

- Requirements Analysis
- Sub-network Engineering & Design
- Implementation Coordination
- Prototyping Activities
- Network Traffic Modeling

5.6.3 Custom Service

This category of service has been designated to cover other telecommunications services not specifically covered by the standard NISN services that are described in this document. Custom requirements are analyzed and design and implementation are done on a case by case basis.

5.6.4 Globally Interconnected Advanced Network Telepresence (GIANT):

The GIANT system is a worldwide network of advanced tools (hardware and COTS software) that are designed to create a single planning environment for use by the globally distributed International Space Station (ISS) operations planners. This service is customized for ISS use only.

The unit of service is a SOMO quote.

5.7 Information Technology and Network Infrastructure Services

The following describes services provided by SOMO which support the Agency's Information Technology (IT) and networking infrastructure. Some of these services are provided on an institutional basis and therefore not separately ordered by customers as a Catalog service. These service descriptions are informational for the customer. If the customer determines these institutional services necessary, then they should contact the local Center NISN Service Representative for information on scheduling and use of these services.

Table 5-13: Information Technology & Network Infrastructure Services

Service ID	Service Title	Unit of Service
2.7.6.01	Domain Name–NASA.gov	Institutional
2.7.6.02	NASA Directory (X500)	Institutional
2.7.6.03	Conference Support	Cost/Conference
2.7.6.04	Russia Information Technology	SOMO Quote
2.7.6.05	NISN Requirements Management Support	Annual Staff Cost; not including travel
2.7.6.06	Research Support	SOMO Quote

5.7.1 DOMAIN NAME SERVICE - NASA.GOV

Register and administer the NASA.gov Internet domain naming policies, conventions, and the Domain Name Servers within NASA. Sub-domain management is conducted by the appropriate NASA centers/organizations. Contact the local Center NISN Service Representative for information on scheduling and use of this service.

5.7.2 NASA DIRECTORY SERVICES (X500)

The NASA Directory Service is based upon the international X.500 standard for the organization and presentation of a hierarchical directory service infrastructure. The SOMO NISN organization provides an infrastructure consisting of an Agency level system and centralized support of center level systems for maintaining the disbursed hardware and software systems.

The NASA Directory Service was primarily established to assist in the standardization of the various NASA electronic mail addressing and look-up. The use of the Directory Services has expanded to include FAX number, pager number, building and room, telephone number, a unique identifier, and address look-up information. The capability of using the directory service for supporting public-private key encryption systems to support privacy and authentication needs of Agency programs is now being implemented. Contact the local Center NISN Customer Service Representative for information on scheduling and use of this service.

5.7.3 CONFERENCE SUPPORT SERVICES

NISN Conference Support Services include the planning, design, management, and implementation of the special communication needs to support NASA sponsored or supported conferences and symposia. These support services may include one or more of the following elements:

- Local Area Network planning and/or installation
- Wide Area Networking ordering, connectivity, LAN interfacing
- PC Workstations for Internet access
- Audio/video systems & support

NISN maintains a core capability of equipment and personnel to support these conferences. Additional resources can be leased or procured as needed to meet unique requirements.

5.7.4 RUSSIA INFORMATION TECHNOLOGY SERVICE

The Russia Information Technology Service provides Data Distribution and Information Technology (IT) services in support of the IT needs of NASA in communicating with NASA and Russian personnel located in Russia. These services include:

- Personal Computers, software applications, servers, and local area networks comprising office automation infrastructures
- Phone/Facsimile Service
- Voice and Video Teleconferencing
- Data services
- Voice loops
- Electronic Mail
- 24/7 Hour Network Monitoring
- 24/7 Help Desk
- Mission support for the Houston Support Room (HSR) at MCC-M

- Web services for online guidelines and procedures, phonebooks … etc.

- IT and Telecommunications Life-cycle support: from Hardware/Software Procurement, Crating, Shipping, Exporting, Importing Controls, Security Procedures and Installation.

This service provides a significant variety of support to NASA projects working in association with the Russian Federation. Major projects currently supported include the International Space Station, an Earth Observing System (EOS) experiment, and the interchange of data and information between NASA's and Russian science communities.

5.7.5 NISN REQUIREMENTS MANAGEMENT SUPPORT

Includes the identification, technical analysis, initiation, and management of requests for NISN services in support of HQ NASA Enterprise elements and their associated scientific community. Requirements Managers (RM's) coordinate with the appropriate NASA enterprise managers and customers to match NISN services and capabilities to requirements of the academic, scientific, and operational communities in support of NASA strategic goals and objectives. A principal function of RM's will be to assist the academic and scientific community to devise cost-effective NISN solutions to satisfy their scientific research missions. A principal feature of the RM's task is direct customer interaction, necessitating occasional to frequent travel to customer locations, forums, and symposia. NISN RM's also assist NASA enterprise elements with NISN service acquisition, management, and resource allocation. The unit of service is the annual staff cost (not including travel) per support.

5.7.6 RESEARCH SUPPORT

Includes providing networking services, equipment, engineering, and operations required to carry out defined networking and technology research, and related applications demonstrations, in support of Next Generation Internet (NGI) and related national and NASA-specific research programs. Deliverables for each task will include network connectivity; custom proofs of concept; engineering analysis; planning, design, and execution phase reviews; readiness review participation; demonstration support and lessons learned; and technology transition planning, execution, and evaluation. The unit of service is the actual cost of the support which will vary based on individual requirements.

6.0 REFERENCE DOCUMENTS

Prospective users of SOMO facilities can obtain additional information from the following documents:

1. ***Services Catalog,*** NASA Space Operations Management Office, Lyndon B. Johnson Space Center, National Aeronautics and Space Administration, Code TA, 2101 NASA Road 1, Houston, Texas 77058.
   Copies of the document are available at:
   http://www.csoconline.com/servicescatalog.htm

2. A***MMOS and DSN Support of Earth Orbiting and Deep Space Missions***, Document D-13973, Telecommunications and Mission Operations Directorate, Jet Propulsion Laboratory, Pasadena, California, Latest Edition.
   Copies of the document are available at:
   http://deepspace.jpl.nasa.gov/advmiss/

3. ***NASA/GSFC/WFF Ground Network Resources***.
   Copies of the document are available at: http://www.wff.nasa.gov/~code452/

4. Space Network Users' Guide, Latest Edition.
   Copies of the document are available at: http://nmsp.gsfc.nasa.gov/tdrss/

5. Consultative Committee for Space Data Systems (CCSDS).
   Copies of CCSDS Recommendations are available at:
   http://www.ccsds.org/ccsds/